New Technology for Monitoring Cycle Chemistry

THORNTON
Leading Pure Water Analytics

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McIlvaine Hot Topic Hour
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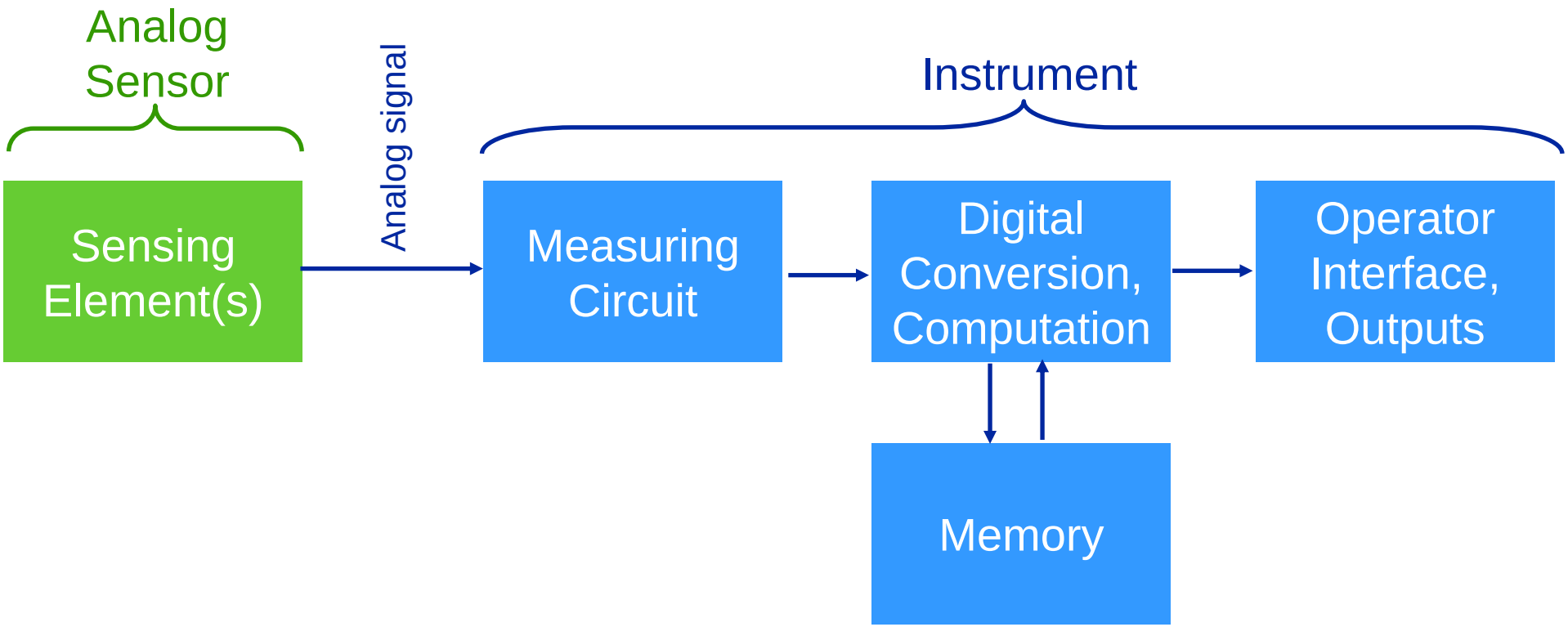
METTLER TOLEDO

Outline

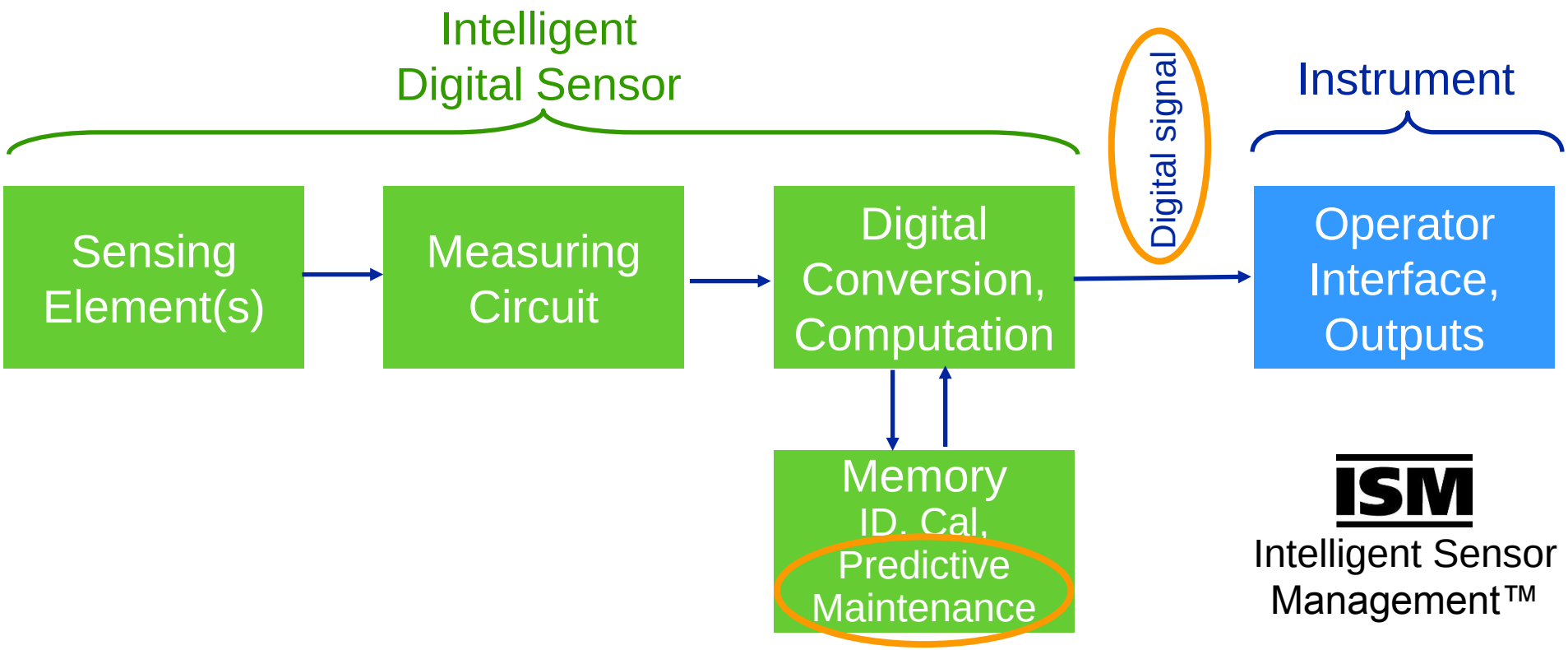
Sensor developments

- Measurement parameters
  - Conductivity
  - pH/ORP
  - Dissolved oxygen
  - Sodium / Silica
- Multiparameter instrumentation
- Conclusion

Measurement Functions—Conventional Sensor



Measurement Functions—Intelligent Digital Sensor



Performance and maintenance are improved significantly with signal handling and intelligence contained within the sensor

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Conductivity Sensor Reliability

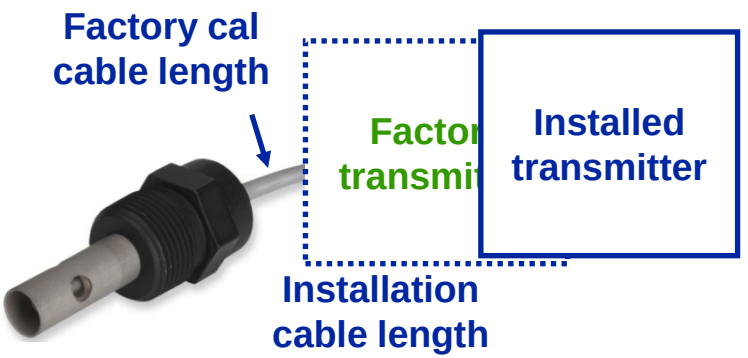
- Sensor reliability can depend on cell constant
- Many instruments require very low constant sensors with close spacing and large surface area for pure water measurements.
- Corrosion products, deionization resin particles or bubbles can accumulate between electrodes, causing large errors.
- Systems using higher constant 0.1 cm^{-1} sensors such as intelligent digital sensors, provide wider electrode spacing that prevents accumulation of particles, resulting in less cleaning, greater reliability and longer sensor life.

0.01 cm^{-1} constant

0.1 cm^{-1} constant

Conductivity Measurement Accuracy

- Accuracy depends on
  - Measuring circuit calibration
  - Cell constant calibration
  - Temperature calibration
  - Installation variables—cable length, etc.
- Conventional sensor and transmitter
  - Calibrate sensor with one transmitter/cable; measure with another transmitter/cable
  - Errors of transmitter, cable and sensor can be cumulative
- Integrated digital sensor
  - Calibrate and measure with the same internal circuit
  - Reduced error



Digital output

With digital, intelligent sensors, accuracy is unaffected by cable length or the particular transmitter used for calibration

Digital Conductivity Sensor Accuracy

- Digital sensors deliver significantly better system accuracy
  - Analog conductivity systems calibrate the sensor element and measuring circuit in the transmitter separately, with contributions to error from both, e.g.
    - Sensor cell constant accuracy: ± 1%
    - Transmitter accuracy: ± 0.5%
    - System accuracy, ± 1.5%, plus cable effects
  - Digital conductivity system accuracy
    - No error contributed by transmitter
    - No error contributed by cable or noise pickup
    - System accuracy = cell constant accuracy = ± 1%, a 33% improvement in accuracy
    - Factory calibration accuracy = installed accuracy

Intelligent digital conductivity sensors can reduce errors by at least 1/3 compared with conventional analog sensors

Digital Conductivity Measurement Rangeability

Rangeability and Accuracy

- Titanium 0.1 cm^{-1} constant sensors—pure water to 50,000 µS/cm
  - 0.02 to 5,000 µS/cm, ± 1% installed accuracy
  - 5,000 to 50,000 µS/cm, ± 3% installed accuracy
  - Orders of magnitude wider range than other sensors

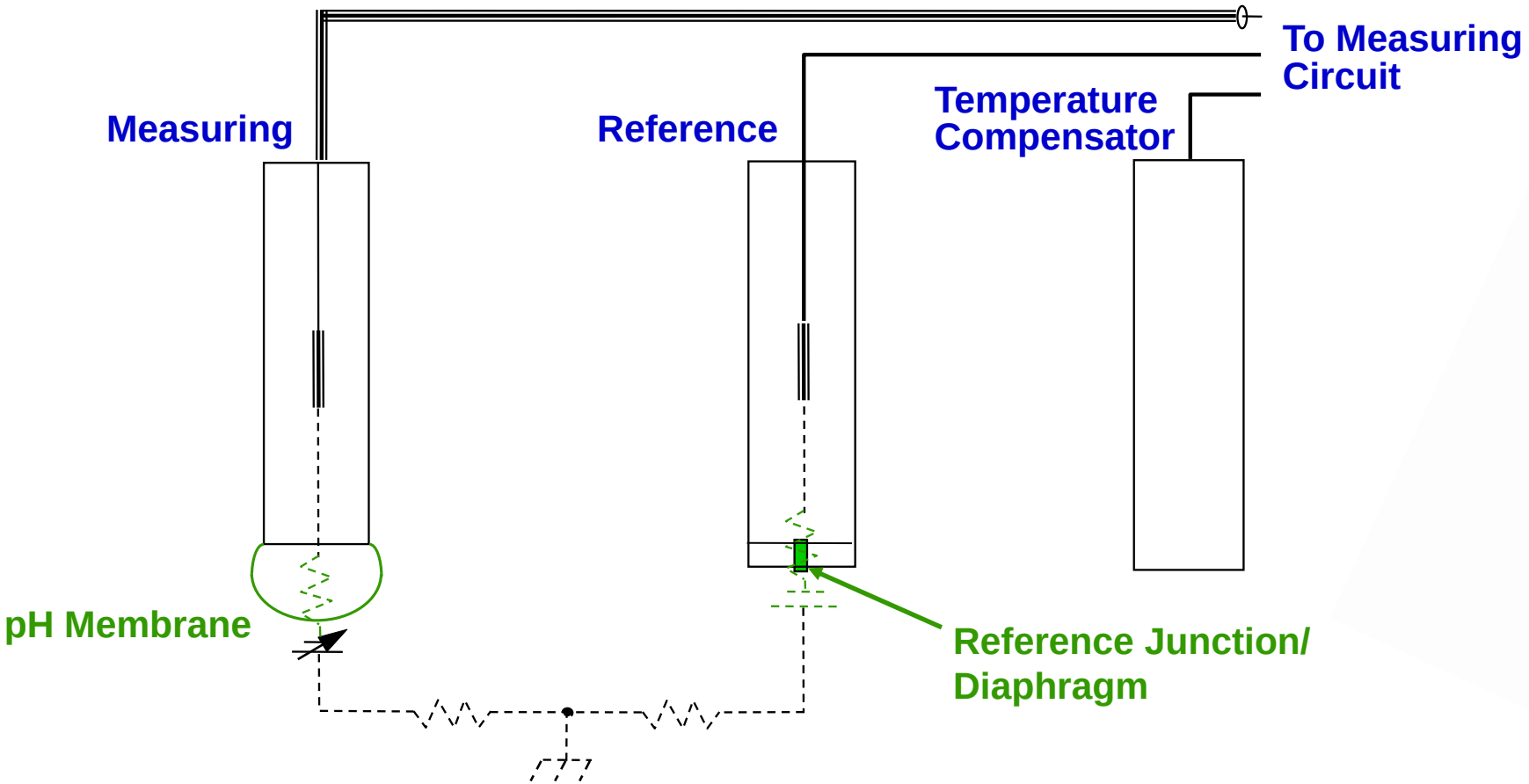
Intelligent digital sensors provide significantly higher accuracy and wider rangeability than conventional conductivity sensors.

Conductivity Summary

- Sensor with widely spaced electrodes / relatively high cell constant, to prevent fouling
- Low volume sensor flow housing for high flow velocity
- Accurately calibrated cell constant and temperature
- Integral measuring circuit and digital signal conversion
- Proven temperature compensation algorithms
  - Ammonia/amine compensation for specific conductivity
  - Cation compensation for cation and degassed cation conductivity
  - High purity compensation for deionized makeup water

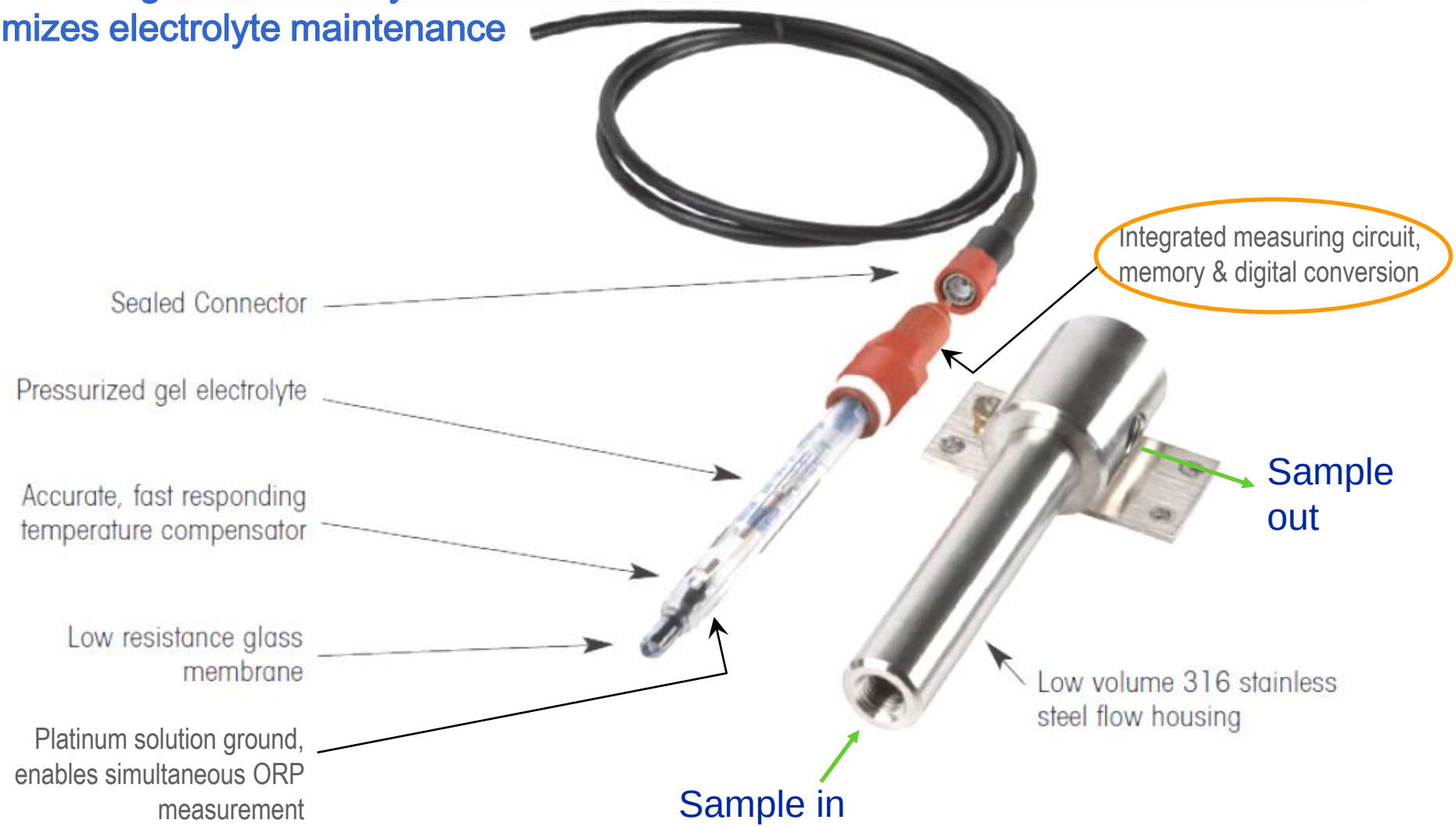
pH Measurement

- Electrode System Schematic



Intelligent High Purity pH Sensor

Pressurized gel reference system minimizes electrolyte maintenance



Intelligent Liquid Electrolyte High Purity pH Sensor

Liquid electrolyte reference system maximizes accuracy

Integrated measuring circuit, memory & digital signal conversion

Visible liquid electrolyte level

Protective cover

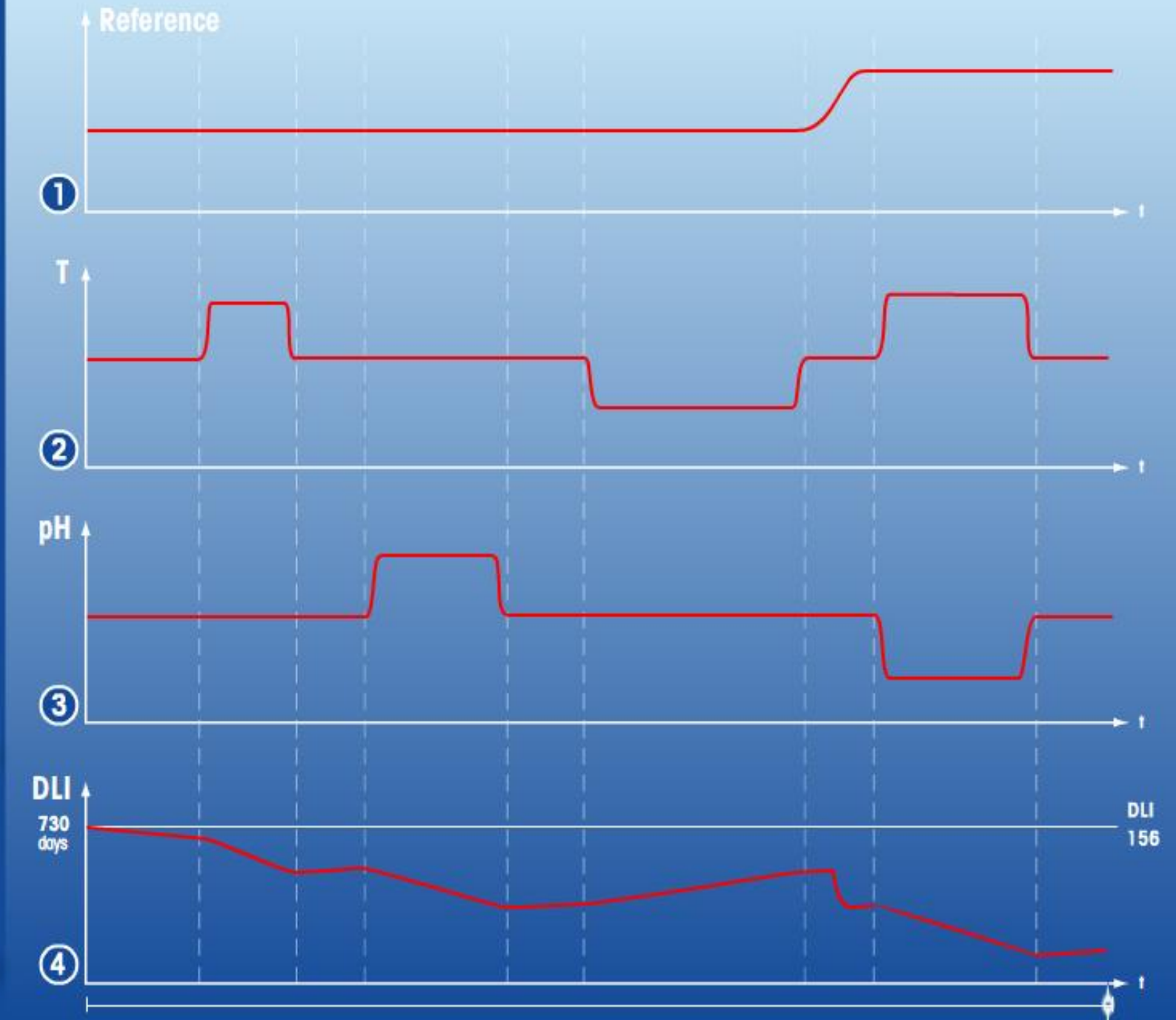
Buffer solution containers

Sample out

Sample in

Measuring electrode
Reference electrode
Temp. compensator
Solution ground

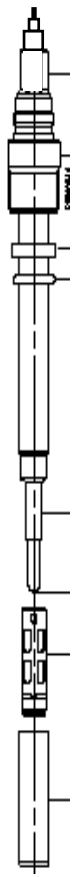
Predictive Diagnostics for pH



Predictive Diagnostics

Predictive diagnostics provide guidance on when and what is required to maintain the sensor

Intelligent Dissolved Oxygen Sensor



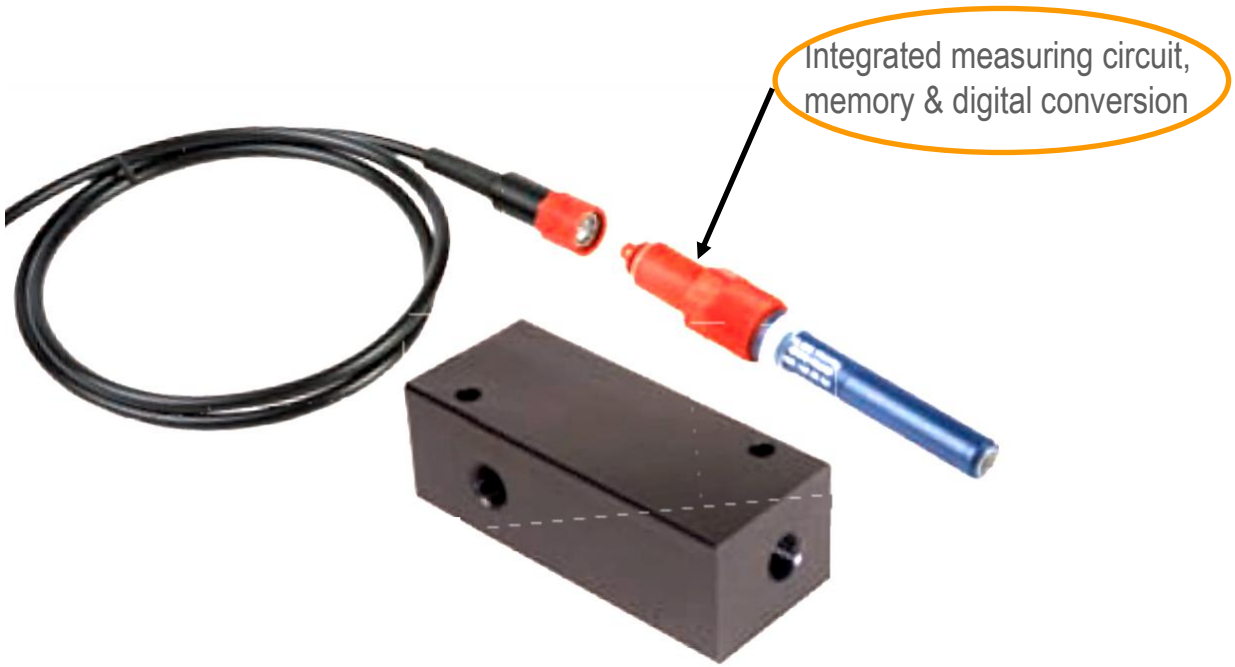
Measuring Circuit, Digital Conversion, Memory

Anode

Cathode and Guard Ring

Membrane Body with Electrolyte

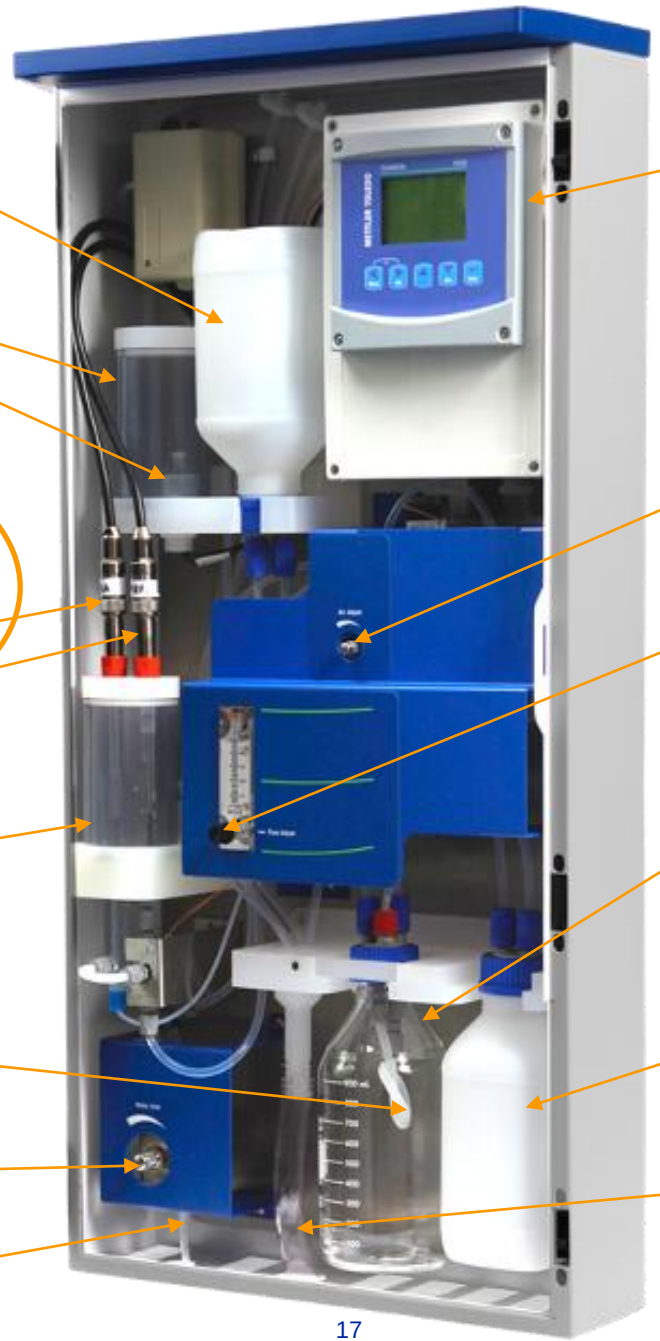
Cap Sleeve



Predictive Diagnostics

- Adaptive calibration timer—air calibration
- Time to maintenance—membrane/electrolyte change
- Dynamic lifetime indication—electrode change

Intelligent Sodium Analyzer



Grab sample bottle

Overflow chamber

Flow/level switch

Integrated measuring circuit, memory & digital conversion

Sodium electrode

pH/reference electrode

Measuring chamber

Diffusion tubing

Sample inlet valve

Sample inlet

Intelligent Transmitter

Air flow valve

Sample flow indicator & valve

Reagent bottle

Calibration standard

Drain

Intelligent Silica Analyzer

Overflow chamber

Calibration standard & grab sample bottle

Level / flow switch
Temperature sensor

Sample flow indicator & control valve

Reaction chamber

Integrated measuring circuit, memory & digital conversion

Intelligent Transmitter

Reagent pumps

LED

Photo diode

Reagent bottles

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Multiparameter instrumentation

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Multiparameter Intelligent Instrumentation

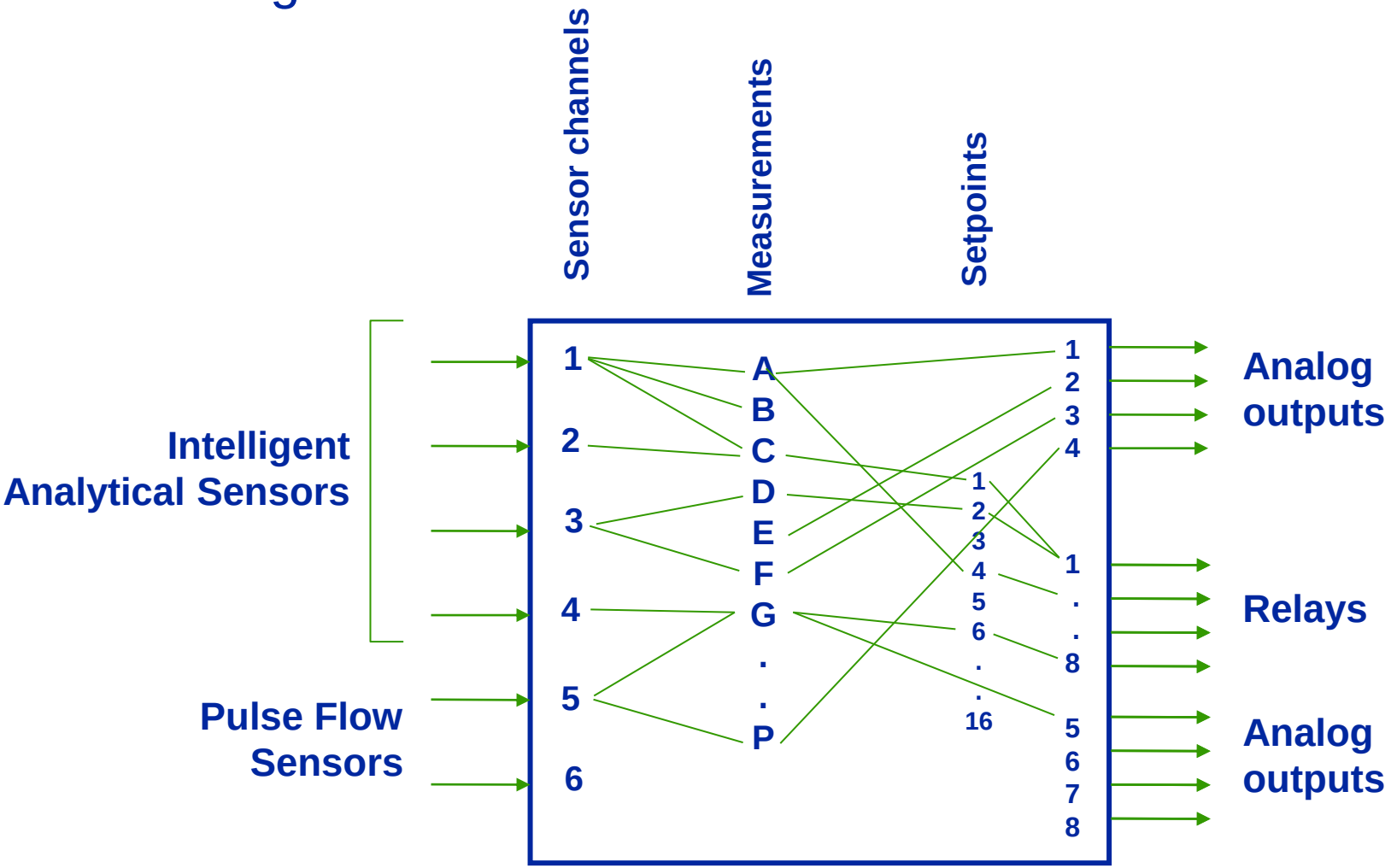
- Common platform for many parameters
- Automatic recognition and interchangeability of sensors
- Reduced panel space requirements
- Reduced spare parts requirements
- Internal calculation of derived parameters
- Predictive maintenance

Derived Parameters

- Makeup water treatment
  - RO % salt rejection - product and feed conductivity
  - RO % flow recovery - product and reject flowrate
  - Deionization capacity - $\int$ flow x TDS dt
- Cycle chemistry
  - Calculated pH - specific & cation/acid conductivity
  - Calculated CO_2 - cation & degassed cation conductivity

Multi-Parameter Flexibility

- Configuration



Multiparameter Intelligent Sensor Measurement

- All parameters for a sample can be displayed on one screen
  - Specific conductivity
  - Cation conductivity
  - Calculated pH
  - Electrode pH
  - ORP (redox potential)
  - Dissolved oxygen
  - Sample temperature

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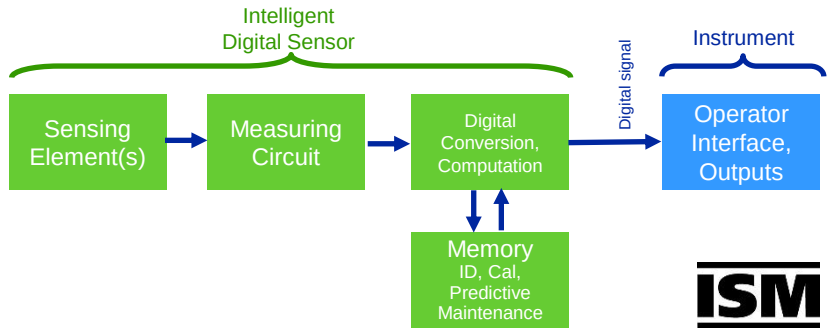
Intelligent Sensor Summary

- Digital Intelligent Sensors
  - Measuring circuit
  - Digital signal conversion
  - Extensive memory
  - Predictive diagnostics
- Conductivity
  - Improved accuracy
  - Much wider rangeability
- pH
  - Improved signal reliability
  - Predictive diagnostics
- Dissolved oxygen
  - Improved signal reliability
  - Predictive diagnostics
- Enables full benefit of multiparameter instrumentation



Intelligent digital sensors: the future of process analytics.
More information is available at www.mt.com/pro_power